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PROVIDED IN THIS REPORT ARE COMPLETE TEXTS OF SEVERAL RESEARCH PAPERS PRESENTED FOR "PROJECT LITERACY." THE CENTRAL THEME OF EACH PAPER IS BASIC RESEARCH AND/OR CURRICULUM DEVELOPMENT IN AREAS OF EDUCATION RELEVANT TO THE ACQUISITION OF READING SKILLS. TITLES OF THESE PAPERS ARE (1) "MOTIVATIONAL CONTENT ANALYSIS OF PRIMERS," (2) "OUTLINE OF RESEARCH ON THE ENGLISH OF NEGRO AND PUERTO RICAN SPEAKERS IN NEW YORK CITY," (3) "VERBAL AND VISUAL ELABORATION IN PAIRED ASSOCIATE LEARNING," (4) "EIDETIC IMAGERY IN CHILDREN," (5) "ADULT-CHILD INTERACTION IN PRESCHOOL YEARS," (6) "THE CHILD'S KNOWLEDGE OF ENGLISH PLURALIZATION RULES," (7) "A STUDY OF SELECTED GRAPHEME-PHONEME CORRESPONDENCE PATTERNS," (8) "ON THE INTERACTIONS OF MEMORY AND PERCEPTION," (9) "THE ROLE OF PRONOUNCEABILITY IN PERCEPTION OF PSEUDO-WORDS BY HEARING AND DEAF SUBJECTS," (10) "PERCEPTUAL 'CHUNKING' AND STORAGE IN READING WORDS," AND (11) "SENTENCE STRUCTURE AND THE EYE-VOICE SPAN." (JH)

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MOTIVATIONAL CONTENT ANALYSES OF PRIMERS*

Gaston E. Blom, Richard R. Waits and Sara Zimet

University of Colorado Medical Center

Introduction

In a previous report at the Project Literacy Conference in September 1964, we cover the rationale for our studies, our methodological procedures and problems, and some preliminary data. The rationale for our research is based on the assumption that the kinds of materials used in introducing children to reading have an influence on their interest in reading.** Therefore, part of the project was designed to investigate the content of primers and pre-primers currently in use, in terms of a number of dimensions and of the interactions among them. These dimensions include level, story themes, several attributes of characters in the stories, sex of the activities depicted in the stories, age of these activities, and outcome of these activities. The dimensions and categories within them are described in a coding manual. We have been able to achieve good reliability in the independent coding of stories by trained raters.

Research Progress

At this point the coded data on 1307 stories in 12 of the most commonly used publishing series (defined as the original national sample) have been analyzed along the dimensions used in the content analysis.

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* Supported by U. S. Office of Education Cooperative Research Project 3094.

** Interest has also existed in attitudes and values as conveyed through the content of stories.

They are reported in terms of frequency distributions within each dimension and of interactions among certain dimensions. In addition the data have been analyzed to test three hypotheses which were originally derived from a clinical examination of the content of all stories in two publishing series.

We are currently involved in a number of other studies related to the content analysis project. Some of them will be mentioned to show the directions in which our research has been proceeding.

One study in process concerns the use of factor analysis to determine if a few factors can be obtained and meaningfully described that will characterize the content of 1307 stories in a more global way. The results may or may not offer certain advantages over a dimension by dimension analysis and more simple single dimension interactions. If a few clear factors emerge, we have considered using them as a basis for constructing a questionnaire for children to determine reading preferences according to content.

Another study involves the continued coding of other publishing series as they have become available. Some of these are revised editions while others are special, new, historical, and experimental editions. To date 20 series, 8 more than our original 12, have been coded, comprising overall somewhat less than 2300 stories. We have had a special interest in multi-ethnic urban readers that are now being published (5 are available to us at the moment). We have coded and partially analyzed the data on an old McGuffey First Reader, a modern McGuffey series (Golden Rule Series), and compared some of the results to those of the original national sample. Four new dimensions of the content analysis were developed from further coding of multi-ethnic urban readers. These are: environmental setting of the story, ethnic composition of the characters, agent of failure or frustration, and object of failure or frustration. A further category in the outcome dimension was also developed: self-help (where a child is thwarted and helps himself).

A further study by one of us*** is the subject of a doctoral dissertation. This consists of the historical change in masculine and feminine roles as conveyed through the content of stories. The stories to be analyzed are from representative first readers used in the United States during historical periods from the 16th through the 20th centuries.

A further study is the compiling of a motivational index of the 1307 stories in the original national sample. This index will make available to regular classroom teachers and to remedial reading teachers stories that have been coded according to our dimensions. It will be possible to select stories that depict content of particular motivational interest to individual children and groups of children.

Original National Sample Data

Since the total data comprise a large amount of material, only selected data will be presented that are representative of our findings. While overall findings (i.e., those of the entire group of 1307 stories combined) are stated, there are differences among individual publishing series and particular series which influence the overall results. These

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*** Mrs. Sara Zimet

will be made clear in some of the tables.

TABLE I

Frequency distributions - Theme

	No. of Stories	%
Real life with positive affect	303	23
Active play	162	12
Pets	152	12
Outings	107	8
Imaginative Play	94	7
Real life with negative emotions	93	7
Nature	83	6

	No. of Stories	%
Work Projects	76	6
Folk Tales	78	6
Quiet Activities	41	3
Pranks and humor	37	3
School	35	3
Parties	20	2
Lessons from life	14	1
Aesthetics	7	.5
Unclassified	3	.5
Religion	0	0

Table I indicates that 3 categories account for 47% of the stories. In 9 of the 12 series they accounted for over 40% of the stories. The first category, real life situations with positive affect, can be described as polyanna stories. It is ranked first in 8 of the 12 series. Aesthetic appreciation, lessons from life, parties, pranks, quiet activities, and school are all in low frequency. The themes tend to be limited to a narrow range of topics of neutral significance.

Table II indicates that 3 of 10 categories make up 53% of the stories. In 8 of 12 series these categories make up over 50% of the stories. Ranked first is children and animal stories (over 20% in 8

TABLE II

Frequency distributions - character

		%	Rank
Children and animals	N = 296	23	I
Children and mother	N = 202	16	II
Children, mother and father	N = 188	14	III
Children and other adults	N = 175	13	IV
Children only	N = 146	11	V
Animals only	N = 134	10	VI
Children and father	N = 112	9	VII
Adults only	N = 27	2	VIII
Make believe characters	N = 14	1	IX
Inanimate objects	N = 11	1	X

of 12). In striking low frequency are stories of make believe characters (1%) (6 of 12 had none), inanimate objects (1%) (6 of 12 had none), and adults only (2%) (4 of 12 had none). There are nearly twice as many stories in the category children and mother (16%) as children and father (9%).

Of 1307 stories, 1161 involved children as characters. These 1161 stories were rated according to age (6 years, $<$ 6 years, $>$ 6 years), sex (boy and girl), and family membership of central characters (family and non-family). Table III indicates that "little sister" ($<$ 6 years, girl, family) appears in 34% of stories while "little brother" appears 6%. "Big brother" ($>$ 6 years, boy, family) occurs in .8% of stories while "big sister" in .3%.

TABLE III

Distribution of children according to Age, Sex, Family

Group	No. of stories in which group is represented	Percentage of Total 1161	Rank
Boy - age 6 - family	897	77%	I
Girl - age 6 - family	837	72%	II
Girl - < 6 - family	389	34%	III
Boy - age 6 - non-family	340	29%	IV
Girl - age 6 - non-family	278	25%	V
Boy - < 6 - family	69	6%	VI
Boy - < 6 - non-family	64	5.5%	VII
Boy - > 6 - non-family	38	3%	VIII
Girl - < 6 - non-family	29	2.5%	IX
Girl - > 6 - non-family	9	.8%	X
Boy - > 6 - family	9	.8%	X
Girl - > 6 - family	4	.3%	XII

There were 692 family only stories, 65 non-family stories, and 410 family and non-family stories, showing the preponderance of family centeredness of the characters. In addition Table IV indicates that the most frequent patterns of children in stories is boy age 6 - family, girl age 6 - family, and girl age < 6 - family.

TABLE IV

Distribution of Pattern of Children
According to Age, Sex, Family

Distribution	Amt.	% of 1307	Distribution	Amt.	% of 1307
B6F, G6F, G<6F	251	19.2	B6F	55	4.2
B6F, G6F	234	17.9	Imaginary Character, Inanimate object & Adults only	52	3.9
Animals only	134	10.2			
B6F, G6F, B6N G6N	64	4.9	B6F, B<6F, G6F	48	3.7

There is a difference among the individual series as to preponderance of pattern.

Data in Relation to Three Hypotheses****

Three hypotheses were derived from a clinical examination of stories and tested by means of content analyses of the 1307 stories in the national sample. They were: 1) The activities depicted in the stories are those which are engaged in by children of less than six years; 2) the activities are most frequently those which are engaged in by girls; 3) the masculine activities depicted end in failure more frequently than do the feminine activities.

TABLE V

Summary of Ratings on Age of Activity

Age	2-3	4-5	6-7	8-9	10-11	Total
Frequency	23	497	547	226	14	1307
Summed Frequencies	520		273.5	513.5		1307

**** To be published in the Elementary School Journal.

To test the first hypothesis, one-half of the 6-7 year group was assigned to each year (i.e., 273.5 for year 6 and for year 7). Summing the frequencies shows no appreciable difference between the number of stories where the age of activity is greater than 6 years and the number less than 6 years. Hypothesis 1 is not supported by the data.

TABLE VI

Summary of Ratings on Forced Sex***** of Activity

Sex	Boy	Girl	Boy-Girl	Total
Frequency (original)	339	369	599	1307
Frequency (forced-sex)	620	585	102	1307

The results do not support the second hypothesis. However, the large number of stories in the Boy-Girl category (46%) on the original ratings suggest ambiguity in sex role. In 10 of 12 series boy-girl activity exceeded boy or girl activities.

TABLE VII

Interaction Between Forced Sex and Outcome Ratings

Forced Sex	Success	Failure	Help	Unclassified	Total
Boy	379	181	56	4	620
Girl	394	135	54	2	585
Boy-Girl	64	30	4	4	102
Total	837	346	114	10	1307

***** All boy-girl stories were recoded in an attempt to reassign each to either boy or girl wherever possible.

The results show a statistically significant interaction between sex and outcome, ($X^2 = 23.8, p < .001$). The procedure described by Castellan for the partitioning of contingency tables was used to determine that this specific interaction was significant, ($X^2 = 8.76, p < .005$). Hypothesis 3 is supported by this finding.

In trying to understand why the first two hypotheses did not gain support, the data were reanalyzed in relation to copyright data. Those series published in 1961 or before (N = 6) were compared with those published since 1961 (N = 6).

TABLE VIII

Interaction Between Copyright Date and Age Ratings

	Age of Activity			
Publication Date	Less than 6	6	Greater than 6	Total
1956-1961	313	140	238	691
1962-1963	207	133.5	275.5	616
Total	520	273.5	513.5	1307

The interaction between the 1956-1961 copyright group and age of activity is significant ($X^2 = 20.3, p < .005$).

TABLE IX

Interaction Between Copyright Date and Forced Sex Ratings

Sex (forced choice) of Activity

Publication Year	Boy	Girl	Boy-Girl	Total
1956-1961	280	350	61	691
1962-1963	340	235	41	616
Total	620	585	102	1307

Again the interaction is significant, ($X^2 = 17.4$, $p < .001$).

TABLE X

Interaction Between Forced Sex and Outcome of Activity (1956-61)

Outcome

Sex	Success	Failure	Help	Undecided	Total
Boy	182	77	18	3	280
Girl	262	61	26	1	350
Boy-Girl	42	12	4	3	61
Total	486	150	48	7	691

TABLE XI

Interaction Between Forced Sex and Outcome of Activity (1962-63)

Sex	Outcome Success	Failure	Help	Undecided	Total
Boy	197	104	38	1	340
Girl	132	74	28	1	235
Boy-Girl	22	18	0	1	41
Total	351	196	66	3	616

The interaction between sex and outcome is significant in the pre-1961 group, ($X^2 = 20.6, p < .005$), while it is not significant in the post-1961 group, ($X^2 = 11.0, p > .05$).

All 3 hypotheses are supported in the pre-1961 group but not in the post-1961 group. This suggests that a change in the content of stories in primers occurred around 1961-62. This would be consistent with the influences occurring at this time: of the cognizance given reading disability in boys, of publicated criticism of readers, and of research on sex differences in learning patterns. These historical findings will be explored in further studies of pre- and post-1961 revisions of the same series and of other publishing series in these year groups.

Summary

Given some differences within publishing series and some changes in content that appear to have occurred around 1961-62, a Gestalt for the stories in the original national sample can be described. The activities are neutral and redundant without much content significance and variation. They are family centered and tend to be ambiguous as to sex role. Older age children as siblings and peers rarely appear. From a developmental viewpoint there tends to be a regressive pull. The setting is in the suburbs.

OUTLINE OF RESEARCH RESULTS ON THE ENGLISH OF NEGRO AND PUERTO RICAN SPEAKERS IN NEW YORK CITY

Paul S. Cohen

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The research outlined here (U. S. Office of Education projects 3091 and 3288: Professor William Labov, Director) has been in progress since 1965. The purpose of the investigation is to formulate an accurate linguistic picture of the English of Negro and Puerto Rican inhabitants of New York City, in order to determine the structural and functional conflicts between their English and the standard English of white New Yorkers--conflicts which prevent such a large number of Negro and Puerto Rican youth from learning how to read, in any real sense of the term. (Our investigations thus far have been largely among Negroes.)

To this end, we have gathered, to date, several hundred tape-recorded interviews with different segments of the population, with geographical emphasis on the Central Harlem area. Last summer, over fifty interviews were conducted with Negro boys aged 9-12 in the summer day camp centers throughout Harlem. Interviews are still being gathered among Negro boys aged 10-17 from selected lower-class, working-class, and middle-class blocks in different parts of Harlem. For the sake of comparision adult interviews and interviews with working-class white boys are currently being gathered.

Two or three boys who hung around together were first interviewed individually. Then they were invited to bring along several of their friends for a group interview at our offices, with the understanding that it would be a relaxed, informal get-together with refreshments. Each boy was hooked up to a separate microphone and tape recorder. Some initial failures encountered in using a single tape recorder for groups convinced us of the impossibility of determining, with any degree of concidence, who was talking at any time; and, indeed, we found that a significant portion of speech was inaudible on overall group tapes which were clearly audible and easily attributable on individual tapes.

From a purely linguistic standpoint, the purpose was to elicit as full a spectrum of speech-style variation as possible, from the most formal--reading of word lists and minimal pairs--to the most casual--discussions of games and fighting, joke-telling, etc. We found, pretty much as we had expected, that we had no difficulty in getting formal speech in individual interviews, since the interviewer was a strange adult, the tape recorder was present, and most often the interviews were conducted in empty schoolrooms and offices. The entire situation was judged by the child as being appropriate for formal behavior, despite attempts by the interviewer to indicate that informality was called for. There was little casual speech to be found in these interviews. In the group interviews, on the other hand, there were large portions of casual speech. A comparison of the performance of ten speakers in individual and group interviews showed that there was very little difference in their phonology and syntax, though, of course, a large difference in intonation, lexicon, content, and volume of speech. Thus we felt justified in using data from both individual and group interviews for phonological and syntactic analysis. The largest phonological differences seem to occur between formal non-readnng and formal reading styles, rather than, as in the case with white New Yorkers, between casual style and formal non-reading style.

It is, of course, phonological and syntactic differences between this dialect and standard English that are most important structurally, from the point of view of the acquisition of reading skills.

It should be realized that phological and syntactic divergences work as mutually contributory forces in deterring the process of learning to read. In fact, it is at the interface between phonology and syntax, where phonemic units represent grammatical categories, in that the most pervasive effects are seen. We find (among other deviations, for the most part less relevant to reading) three sources of structural conflict:

1) The loss of preconsonantal and word-final *r*. While it is true that there are many *r*-less dialects of English (including the older prestige dialect of New York City itself), in this dialect the *r* is often lost entirely, unlike the situation in the standard dialect where it is normally replaced by [ə]. In the non-standard dialect we find homonymy between *we*, *we're*; *they*, *their*, *they're*; etc. In addition, the so-called linking *r*, as in *for a while*, is most often deleted, indicating underlying forms like //fɒ//, //ka//, etc. (representing *for*, *car*, etc.), as compared with //fɔr//, //kar//, etc. -- the forms which must be postulated for white New Yorkers. Finally, there is widespread loss of postconsonantal *r*, particularly after fricatives and labials (as in *brother*).

2) The loss or replacement by [ə] or [[illegible]] of preconsonantal *l*. This loss just about obliterates the contracted forms of the future tense, as well as making *y'all* homonymous with *your*, *you're*.

3) The simplification of final consonant clusters, particularly those which comprise one or more instances of /s, z, t, d/, When it is realized that these consonants are the most important signals of the possessive, noun plurals, the third person singular present, and the past tense, it is apparent that their loss gives rise to thoroughgoing grammatical perturbations which have grave consequences for reading comprehension. In order to ascertain the effects of phonological differences (especially consonant-cluster simplification), three types of tests are being used:

1) A perception test which determines whether the child can hear the difference between mess and messed, and between mess up and messed up. Although the /t/ of the grammatically significant cluster is more often preserved before a following vowel in the speech of the children investigated, it is not perceived any more often in either phonetic environment; less than 50% of the nearly two hundred tested could distinguish the present from the past tense forms.

2) A "Classroom correction" test, in which the child is given nine written sentences and is asked to put them into "good schoolroom English." (This test is, naturally, only given to those children who have shown ability to read at the first-grade level or better.) The test includes sentences that range in difficulty from He pick me to Last week I kick Donald in the mouth, so the teacher throwed me out the class. In the former, the child has various options such as changing He to They, or pick to picked or picks; in the latter, throwed and out the tend to absorb a good deal of his attention, and kick, which can only be corrected to kicked, is in the position before the D of Donald where the -ed is usually neutralized phonetically, and thus there is only a visual clue to rely on.

3) Several of the sentences the child reads are constructed in such a way as to give insight into the significance to him of the -ed signal by means of the homograph read (both present and past tense). Therefore, no matter what his pronunciation of passed in When I passed by, I read the posters, we can tell by his pronunciation of read whether he picked up and correctly interpreted the -ed signal.

Our preliminary findings with respect to these three tests are, at least to us, quite surprising. We found no correlation between the preception test and the "Class Correction" test. Indeed, we encountered several instances of children getting 100% on one test and 0% on the other. It does appear, however, that there is a strong relationship between success on the "Classroom Correction" test and reading ability.

All of this would seem to indicate that possibility that much of the time, energy, and money expended on auditory perception training might be more profitable spent elsewhere in the curriculum.

Concerning the functional conflicts alluded to earlier, our findings are less clear-cut. What is apparent if that the conflict between the value systems represented by the non-standard and standard dialects is a very real one, though in many cases it is below the level of conscious attention. To correlate social attitudes with linguistic behavior, we have recently developed a series of subjective-reaction tests. The early data indiate a strong difference between the relative prestige of various speech forms as judged by white and Negro listeners. More data and analysis, however, are necessary before any precise pronouncements can be made in this area.

VERBAL AND VISUAL ELABORATION IN PAIRED-ASSOCIATE LEARNING

William D. Rohwer, Jr.

University of California, Berkeley

Our research has two principal objectives. The first is to test hypotheses purporting to account for the observation that children learn pairs of nouns more rapidly when the nouns are presented in the context of a short sentence in which they are connected by a verb (e.g., The DOG closes the GATE.) than when presented in the context of a phrase in which they are connected by a conjunction (e.g., The DOG and the GATE) or when presented alone (e.g., DOG GATE). The second objective is to assess differences in the use and efficacy of such language structures for paired-associate learning as a function of age and social-class membership.

In the manner of an informal progress report, let me briefly summarize the results of a number of studies performed since I last presented our work to Project Literacy.

One explanation proposed to account for the superiority of verb over conjunction strings noted that a list of the latter is characterized by a higher degree of intralist similarity than the former. That is, in a set of, say, eight strings, only two different conjunctions (and, or) are appropriate for use as connectives, whereas up to eight different verbs may be used. This feature of the two kinds of strings, coupled with the known relationship between intralist similarity and learning difficulty was suggested to be sufficient to account for the observed differences in learning rate. In the experiment performed to test this hypothesis, conjunction strings were compared with three sets of verb strings which differed with respect to the number of different verbs that served as connectives: two vs. four vs. eight. Contrary to the intralist similarity hypothesis, the amount of facilitation produced by the verb strings did not vary as a function of the number of different verbs within each list; all verb conditions produced more rapid learning than that observed for conjunctions.

A second hypothesis met with a similar fate at the hands of an empirical test. We argued that verb strings produce better performance than conjunction strings by increasing the probability of correct response selection. Verbs presumably limit the number of semantically appropriate response nouns more than do conjunctions, thereby reducing the size of the set of response nouns from which the correct one must be chosen. When we equated the number of appropriate responses for the two kinds of strings, however, through the use of a recognition test, the advantage of the verb strings was not reduced, but, in fact increased.

Another hypothesis suggested that verb strings, sentences, are themselves more recallable units than conjunction strings, phrases. If so, verb strings would be more available at the time of responding to stimulus nouns than would conjunction strings and could thereby facilitate performance. Two experiments were performed to evaluate this hypothesis. In the first, the recall of conjunction and verb strings was compared for three different types of recall tasks. The verb strings were uniformly better recalled than the conjunction strings, consistent with the hypothesis of differential availability. Nevertheless, we felt that stronger proof was necessary and reasoned that if the availability hypothesis were valid, and if both conjunction and verb strings were equally available at the time of responding, no difference in performance would be observed. The experiment was conducted in such a way that after the presentation of twelve pairs of nouns in the context of either conjunction or verb strings, Ss were asked to supply the response noun for each pair when shown the remainder of the string in which it had initially appeared. Rather than reducing the superiority of the verb condition, however, this techniques increased the amount of facilitation observed and the availability hypothesis was rejected.

We also supposed that the efficacy of verbs as connectives might have depended upon the fact that those we had used almost invariably implied some kind of overt action involving the objects named by the stimulus and response nouns. So, we compared the learning of a common list of paired nouns when connected by verbs implying overt action (e.g., jumps, breaks, throws) with verbs implying little or no overt action (e.g., sees, needs, likes). Both kinds of verbs produced equivalent amounts of facilitation and this hypothesis, like its forerunners, stands rejected.

Finally, we have also entertained the hypothesis that verb strings produce more rapid learning than conjunction strings because they evoke more effective covert visual responses of the objects named by each of the pairs of nouns. In an attempt to assess separately the contributions of the verbal and visual components of the facilitation process, we created a unique set of paired-associate learning materials. First we made up two lists of twelve paired nouns, all of which were names of familiar objects. For each pair of nouns, both a conjunction and a verb string were constructed. We assembled the 24 objects named by the nouns and photographed each pair on movie film. It seemed to us that conjunction strings implied a stationary grouping of each of the pairs. Thus, the pictorial counterpart of the conjunction condition simply involved placing the two objects in each pair about six inches apart on a neutral gray table and shooting a four-second sequence of these immobile arrays. In contrast, the visual translations of the verb strings invariably consisted of action sequences. For example, one of the sentences was "The DOG closes the GATE." and the film sequence displayed a small toy dog walking to a miniature gate and closing it. Each list of pairs in each condition required 12 such sequences to complete the materials for the study trials of the learning task. The test trial materials were the same for both conditions; the first object of each pair was filmed alone and presented for four seconds, during which time Ss were asked to supply the name of the missing object. Four trials of material were constructed by splicing and reprinting the original sequences in different orders for each trial.

When the materials were ready, we began administering the task to first-grade children drawn from an upper-middle class school. Very quickly, it became apparent that these pictorial materials promoted exceedingly fast learning, so fast that a ceiling effect was virtually certain to appear on the first trial. We decided to forego the luxury of two lists in this research and combined the two 12-item sequences of pairs into a single list of 24 pairs that has been used in the three experiments completed thus far.

The first of the three experiments was a two-way factorial performed on a third-grade and on a sixth-grade sample of upper-middle class children (N = 192). The extraordinary ease with which first-grade children had been able to master the abortive 12 item lists of paired pictures caused some concern that the particular pairs we had chosen to include in the lists were in some respect atypical of the paired-associates used in our previous research. Consequently, we deciced to compare performance on the 24 pair lists presented pictorially (stationary conditions only) with performance on equivalent 24 item lists in which each pair consisted of two nouns, printed and presented by means of a slide projector at a rate equal to that used with the pictorial list. The nouns were, of course, the names of the objects presented by means of the movie film. The second factor, Verbalization, was defined in terms of the type of utterance provided by E as each pair, whether pictorial or verbal, was presented to the Ss. The levels were: a simple recitation of the nouns or of the names of the objects shown (N); a phrase about the two nouns or objects in which they were connected by a conjunction (C); a phrase in which the pair was connected by a preposition (P); and, a sentence in which they were connected by a verb (V). All of the strings were matched for length in terms of number of words. The results are shown separately for the third and sixth grades in Table 1. In general, the verbalization effects were sufficiently consistent with those obtained in other studies using different PAs to satisfy us that the particular pairs comprising the film lists are not unique. As you can see from the tabulated means, the major effect is that pictorial materials produce substantially more efficient learning than verbal materials.

The second film experiment was performed with movie materials exclusively. Each of a total of 216 first-, third-, and sixth-grade children sampled from three upper-middle class elementary schools was assigned to one of six experimental conditions. The two principal factors manipulated were: Verbalization (Naming vs. Conjunction phrase vs. Verb sentence); and, Depiction (Stationary vs. Moving objects). The results are shown separately for the three grades in Table 2. As you can see, in the Stationary depiction conditions, verb strings produced more efficient learning in all grades than naming and conjunction strings. In the Naming verbalization conditions, Moving objects produced more correct responses than stationary ones in the third and sixth grades but not in the first grade.

This latter result is consistent with a strong form of a verbal hypothesis to explain the facilitation of learning, namely, that a verbal description of the members of paired associates is a necessary condition for more efficient learning. Let me try to clarify the argument. Consider two hypotheses. First, it may be argued that sentences facilitate the learning of constituent paired nouns because they evoke more effective images of the objects named by the nouns than do conjunction phrases or simply the nouns by themselves. If so, external visual analogues of the images evoked by the sentences should be sufficient, in the absence of accompanying verbalizations, to increase the amount learned. For third and sixth grade children, this was indeed the case but not for first grade children. The results obtained with the older Ss may be explained as a function of the fact that such children presumably do not do so and do not benefit from the moving pictures, unless some kind of linguistic structure is available, the first hypothesis is contradicted and the second finds support. The second is, of course, that sentences, i.e., particular verbal structures, have properties uniquely fitted for the successful storage and retrieval of constituent nouns.

The conclusion is not firm, however, for a number of reasons. The result itself requires replication which it has not received as yet. Our failure to detect a significant difference for the first-grade children between stationary and moving pictures is not strong evidence in any case since an acceptance of the null hypothesis is involved. Furthermore, the experiment needs to be carried out with younger children for whom it can be shown that uninstructed covert verbalizations of sentence forms are, at most, highly improbable.

Although the status of the theoretical question is still in doubt, the results clearly suggest that one way or another, acquisition is facilitated by both verbal and visual elaboration of elements to be learned.

The third experiment represents a partial replication of the second. The difference between the two is in the populations from which the samples of children were drawn. First, third, and sixth grade children were selected once again, but in this case from lower-class schools. Whereas the average performance of children from the middle-class schools on standardized tests of achievement placed them above the 55th percentile, the average performance of the children from the lower-class schools placed them below the 25th percentile. Frankly, we hoped to find large social-class differences in learning efficiency in those conditions where neither verbal nor pictorial elaboration was provided (N and C Stationary conditions) and to show that those differences could be eliminated by presenting the pairs in action sequences or in the company of sentences or both.

These particular hopes were not fulfilled. As you can see in Table 3, the children from the lower-class schools performed at an extraordinarily high level in all conditions. The moving objects produced more efficient learning in all grades, including the first. The sentences, provided with stationary objects, facilitated learning for the third and sixth grade children but not for first-graders. At this early stage of research with these materials, it is premature to give serious interpretation to the social-class difference in the first-grade groups regarding the relative efficacy of verbal and visual elaboration. Nevertheless, two aspects of the results do deserve emphasis. The first is that children from the lower-class schools, many of whom are unsuccessful at classroom learning, perform most efficiently under the experimental conditions we employed. Secondly, it is clear that children from lower-class schools have the capabilities necessary for making good use of visual and verbal elaboration when it is provided.

Table 1. Mean Numbers of Correct Responses on Two Test Trials as a Function of Grades, Verbalization and Mode

Grade	Verbalization	Mode		Total
		Words	Pictures	
3	N	7.7	14.5	11.1
	C	7.1	11.9	9.5
	P	9.6	14.3	12.0
	V	12.0	16.6	14.3
	Total	9.1	14.3	
6	N	10.0	13.9	12.0
	C	6.7	15.0	10.8
	P	11.6	12.8	12.2
	V	11.2	16.9	14.0
	Total	9.9	14.6	

Table 2. Mean Numbers of Correct Responses on Two Test Trials as a Function of Grades, Verbalization and Depiction: upper-class schools

Grade	Verbalization	Depiction		Total
		S	M	
	N	12.6	14.1	13.4
1	C	13.1	16.5	14.8
	V	16.2	17.3	16.8
	Total	14.0	16.0	
	N	14.5	17.5	16.0
3	C	11.9	16.6	14.2
	V	16.6	17.8	17.2
	Total	14.3	17.3	
	N	13.9	17.9	15.9
6	C	15.0	19.5	17.3
	V	16.9	18.4	17.7
	Total	15.3	18.6	

Table 3. Mean Numbers of Correct Responses on Two Test Trials as a Function of Grades, Verbalization and Depiction: lower-class schools

		Depiction		
Grade	Verbalization	S	M	Total
1	N	11.8	16.5	14.1
	C	12.1	15.4	13.8
	V	14.5	16.8	15.7
	Total	12.8	16.2	
3	N	14.3	18.8	16.6
	C	12.3	17.1	14.7
	V	18.4	16.6	17.5
	Total	15.0	17.5	
6	N	13.2	19.3	16.3
	C	14.4	18.9	16.7
	V	17.7	18.1	17.9
		15.1	18.8	

EIDETIC IMAGERY IN CHILDREN

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This project has been in progress for just over five years. It involved initially locating a small sample of eidetic children and undertaking a longitudinal study of the nature of their eidetic imagery. Recently, far more extensive work has begun on these children, including detailed testing and interviewing. A second and much larger sample was added last year, in which interviewing had also been undertaken. Quite independent of these directions, four expeditions to distinct cultural areas of Central and West Africa examined eidetic imagery in communities that have no written language, though varying degrees of contact with Western languages and symbolic systems. Finally, a study at Smith College with retarded children suggested a greater prevalence of eidetic imagery among those than with normal children especially among retardates who has some evidence of brain injuries. The Office of Education has assumed the financing of this project.

For criteria for the presence of eidetic imagery in a subject and the operations used to assess these criteria are relatively easy to specify and carry out. The child is seated about twenty inches in front of an easel on which are placed individual pictures--usually illustrations taken from children's readers. The child is asked to scan the picture carefully--to move his eyes over every part of it--for thirty seconds. Then the picture is removed and the child is asked to continue to stare at the now blank easel and report anything that he sees. If he does report anything (recorded by a tape recorder), he is allowed to talk freely until he stops.

Then he is asked whether he sees it in front of his eyes or not--whether he sees anything else, etc. (See the paper by Haber and Haber and by Siipola and Hayden for a full description of procedure.) After he says he cannot see any image in front of his eyes he is asked for his memory of the picture. Then the next picture is exposed, repeating the process.

The criteria for eidetic imagery as applied to these kinds of data requires that the child report seeing an image in front of his eyes (nearly always on the surface of the easel), which persists for more than thirty seconds, in which he can report seeing relatively accurate details of the stimulus, which is always described in the present tense, and which can be scanned freely during the report. Most images meeting these criteria are positive in color, although this is not used as a distinguishing mark.

In the American school samples, about five to ten per cent of the children tested meet all of these criteria (N=12 in New Haven and N=25 in Rochester). The duration of images lasts from about 45 seconds to 10-15 minutes, with at least one child being able to retain and revoke images at will. Accuracy of report varies from sketchy to photographic, with a preponderance of images being quite accurate. However, with most children there are omissions and interpolations of details, suggesting that eidetic imagery is not a simple photographic representation of the stimulus maintained in the nervous system. They always scan their image and they also always scan the stimulus. Therefore, there is no way that the reported images could be after-images of the stimulus.

The eidetic child never makes a confusion between tenses when he is describing his images of the stimulus and when he is describing his memory of the stimulus. This is the major criterion to differentiate eidetic imagery from memory. The reports on this are most impressive--even seven and eight-year-olds can make perfectly clear distinctions between when they are seeing something and when they are remembering something they previously saw. Further, since their images usually disappear in stages--different parts of it at different times--many occasions arise when something they saw has now faded, while other parts are still there. If, in the same sentence they mention both, the tenses as well as their descriptions always differentiate which is which.

The work on this project so far has consisted primarily on locating samples of eidetic children and then examining the nature of the imagery itself. No experimental work has yet been undertaken, although this is to be the next step. Without attempting to manipulate their imagery or other potentially interacting variables, all of the testing to date has been concerned with the stability of the imagery over time (particularly how it survives puberty), and with a few of the correlates of eidetic imagery. Attention to the latter has focussed on some intellectual and personality variables, as well as self knowledge regarding the imagery. Developmental histories have also been obtained from parents.

The study of eidetic imagery has had a long history in psychology. In the 1920's and 30's it was considered to be an important phenomenon, since it appeared to be a general early developmental stage that all children went through. By the middle 1930's excitement and interest in eidetic imagery had nearly extinguished. It was difficult to incoroporate the findings of the nature of eidetic imagery into the developmental theories of the day (which is still somewhat true). Many psychologists frankly did not believe that eidetic imagery existed and when they read the literature in detail, evaluation of the methods by which eidetic imagery was assessed usually supported this cynical attitude. For whatever reasons, it dropped out of the Zeitgeist entirely.

It might have stayed out forever except that the concept bears a passing resemblance to some contemporary notions in current perceptual research, particularly that of the short term representational stage of visual storage. While the time durations of short term visual memory are considered to be less than one second, the nature of the image in the two cases might be similar.

For this reason we sought out the old literature on eidetic imagery and decided to try and find a few eidetic children. I am not sure that at that time we believed we could find any--the stage of the literature gives even the most optimistic psychologist pause to consider whether he is wasting his time. But we thought a few months would tell us whether we could locate any and, if we did, then we could begin to ask questions about short term memory. Needless to say, it did not work out that way. As the paper by my wife and myself shows, it took us a year to find even a small sample of eidetic children, but once found they seemed so fascinating in their own right that we have yet to do much else with them but just watch them.

There is no question about the genuineness of the phenomenon. Everyone who has tested or observed the eidetic children responding to their visual images has no doubt that they see something out in front of their eyes, and that from their images they can report information about the stimulus. Beyond this we cannot say much else with assurance. The reports based upon the images are not always perfect, suggesting either that the image is already the result of some encoding process, or at least that distortion occurs when the child translates the image into words. This latter alternative suggests that the amount and kind of errors would be no greater when details are reported from the image than by having an eidetic child report from the actual stimulus on display. In many cases this is true, although in general reports of images are less accurate and have more mistakes then descriptions of the stimulus itself while it is on view.

We do not know very much about the functioning of the image itself--how easily an eidetic child can turn it on or off, whether it changes when projected onto other surfaces, whether he can view it as easily with his eyes closed, etc. We have some incidental observations on these and related questions, and extensive interviews with the children, but no controlled data. It is easy to obtain such data--it just takes time.

In addition to these questions we have little knowledge about the way the possession of eidetic imagery affects other cognitive abilities and processes. It has usually been considered a developmental stage, though seeing eidetic imagery as a general stage presupposes that most children go through it. Our evidence suggests that this is unlikely because of the small percentage of children found who are eidetic, although it is possible that this stage is over by ages 6 to 7 and eidetic imagery remains after that in only a handful of children. But regardless of its generality, in those children who do possess eidetic imagery it is possible to explore how this perseveration of images affects the course of other areas of cognitive development, especially concrete-abstract distinctions, reading skills, memory (especially strategies for encoding and visually presented information into memory) and the like.

The following lines of work are currently under way.

1. Locating a sample of eidetic children in Rochester, New York.

Testing last Spring, 1965, over 400 children in two school systems yielded 24 children who showed clear eidetic imagery. These children are now being tested for the third time, using the testing procedures, though different pictures, that were developed at Yale. We have also interviewed each child extensively about his imagery, especially concerning how much he is aware of it and how much it facilitates or interferes with his other activities. Each parent of these 24 children has also been interviewed-primarily regarding their awareness of their child's ability and what they have noticed or done with respect to it. These results are now being collated. In general the interviews here in Rochester were not very informative, only a few of the children had any awareness of their eidetic imagery at all. It was not so much that they thought all children could do it, but rather that they did not know they were doing it themselves. These findings are in striking contrast to similar interviewing done in New Haven (see below). Needless to say, all parents here are unaware of their child's abilities even though after it became clear to them what we were asking about several parents thought that they themselves were or had been eidetic. We are now in the process of testing these parents. Also, a few of the siblings were indicated by parents to possess eidetic imagery and these will be tested as well. The three retestings for eidetic imagery on the children themselves show that the children and the testing procedures were highly reliable, in that among the 24 all stayed eidetic without gross changes in the amount or quality of their images or memory. No other work has yet begun on these children, although my hope is that some specific testing of cognitive activities can be undertaken this Summer, 1966.

2. Continuing with the New Haven sample of eidetic children.

We are now finishing the last of the analyses of the child and parent interviews in New Haven and of the fifth yearly testing of each of the eidetic children there (see Haber, R. N., & Haber, R. B. Eidetic imagery I: frequency. Perceptual and Motor Skills, 1964, 19, 131-139. for a description of the sample and the first two years of testing). The sample has varied little in make up with only one child moving away. However, several new children have been added--these were three playmates of one of the eidetic children who played games together involving eidetic imagery. When this was reported to us we tested these playmates and found all three also to be eidetic.

The general pattern of results in New Haven is quite different from that of Rochester--primarily, I am sure, because of the repeated testings there with a consequently greater awareness of what we were looking for and of focussing each child on his own abilities. While a few of them in the interviews indicated no awareness, many of them seemed quite conversant with their eidetic abilities knowing when images occurred and why. In addition, even a few of the parents had become aware of their child's ability, though again I am sure it is because of our own intervention.

3. Research in Ghana, West Africa.

Dr. Margaret Feldman, who was conducting the research in Ghana, has recently returned to Cornell University, but I have not received any reports from her yet. We have several meetings planned shortly and further results can be reported then. She completed rather extensive testing in a number of the villages that differed in acculturation to western institutions, as well as in several seemingly relevant belief systems.

4. Other Research on Eidetic Imagery in Africa.

Professor Leonard Doob has been working in three different cultures in Central Africa over the past two years, using procedures developed by this project. (See Doob, L. W. Eidetic images among the Kamba of Central Kenya. Journal of Social Psychology, 1965, 67, 3-22). While his findings have not been perfectly consistent from culture to culture, in general he finds that prevalence of eidetic imagery is negatively correlated with contact with western institutions. It seems unrelated to age (he has several eidetic informants of over 60 years). Among the Kamba of Kenya he has also found what informants called "pictures in their heads", that is, in addition to seeing a visual image in front of their eyes which they could scan, they have a mental image in their head. This was much more labile with respect to evocation than eidetic images, since they reported that they could call up pictures in their heads even after a year from the time the scene was over. Doob also uncovered a number of inconsistencies in accuracy of report, suggesting that the eidetic image might not be literal visual image, but already had involved some encoding and translating in mnemonic terms.

5. Eidetic Imagery among retarded children.

Professor Elsa Siipola (Siipola, E. M, Hayden, S. D. Exploring eidetic imagery among the retarded. Perceptual and Motor Skills, 1965, 21, 275-286) using procedures and stimuli developed on this project has reported a study with retarded and brain injured children. She finds a substantially larger percentage of eidetic imagery among the retarded than in the Rochester-

New Haven samples of normal children, and that nearly all of these children were also brain injured--suggesting that some form of brain damage may be present in children with eidetic imagery. While we have had no hint of this in our two U. S. samples, we are now working on this lead--so is Professor Siipola.

ADULT-CHILD INTERACTION IN THE PRE-SCHOOL YEARS

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The purpose of this project is to investigate the development of children's information seeking behavior. There are many kinds of such behavior, ranging from selective attention and visual scanning, to locomotor exploration and physical experimentation with materials, to such social behavior as asking questions. For a variety of reasons we are interested in observing information-seeking behavior in a naturalistic situation; therefore, our investigations are focused upon the overt behavioral exploration and experimentation and social information seeking. Social information seeking is obvious when a child questions an adult or another child, but other kinds of social behavior provide the child with information even though that is not the child's intention. For example, if a child merely states a belief openly, it is possible for adults or other children to correct him or to argue with him about it. The social interaction thus established may well end up with the child having more information that when he began.

Our first explorations of this topic took the form of the collection of behavior samples on several types of pre-school programs: a pre-school program in East Harlem for children of working mothers and two private nursery schools with clienteles largely from professional, artistic and academic families. Also, we had available the transcripts of eight 20 minute play sessions in a small experimental play room at Cornell. There were two groups of children, each consisting of four children, accompanied by a teacher. Each group played in the playroom for a sequence of four twenty minute periods. In two of these periods the room was set up to resemble the housekeeping corner found in nursery schools. In the other two sessions the room was set up to represent the block corner. Complete records of all the verbal interactions as well as the non-verbal behavior of the children was recorded. Using these records, Mrs. Shirley Cohen, one of the assistants in our research project, has devised a set of categories for children's questions. She has analyzed the records of the Cornell play sessions, categorizing children's questions in the following manner:

1. Asks permanent information.
2. Asks real, transient information.
3. Asks fantasy information.
4. Asks confirmation-hypothesis testing.
5. Asks attention.
6. Asks repetition.
7. Asks permission.
8. Asks assistance.

She has also categorized the responses to the questions in the following set of categories:

Response categories for questions 1, 2 and 3.

1. Gives information requested.
2. Ignores.
3. Don't know.
4. Gives indirect information.
5. Answers self.

Response categories for questions 4 and 5.

1. Direct response to question--gives opinion or gives attention.
2. Ignores.
3. Don't know.
4. Responds indirectly.
5. Answers self.

Response categories for question 6.

1. Direct response to a request for repetition.
2. Ignores.
3. Another person responds to the initial statement so that is is not repeated.
4. Indirect response.

Responses to questions 7 and 8.

1. Direct response to the request.
2. Ignores.
3. Permission or assistance deferred to another person or another time.
4. Indirect response.

Categorization is quite reliable. The percentage of agreement between two coders, basing their coding on the transcript of the observations, is .93. Since the total list of categories is quite long, questions of a particular form may be quite rare. Grouping questions into major types, we find that approximately half of the questions are information seeking. There were only a minimum number of questions which asked permission or asked for assistance. This general distribution of questions is certainly a function of the particular situation. In a mother-child interaction, the same distribution might be very different.

We are now beginning a more formal experimental observation. We have designed a playroom which contained a variety of interesting materials: trains, doll house, a barn with replicas of animals, and a metal board with magnetic letters as well as magnetic shapes of people and objects that can be placed upon it. We also have a rather elaborate lock-box in which there are several kinds of doors, each fastened with a particular kind of catch. Behinds these doors are washers and nuts of various styles and sizes which can be placed on bolts which are fastened into the board.

The procedure is to bring a mother and child into this room, to explain to the mother quite frankly what we are interested in, and to tell her that the child can play with anything he wants in the room. We ask her to behave toward him in the same way that she would behave in any other new situation. We then record the complete verbal interaction between the mother and child on tape, and on the other tract on the same tape, we obtain a running descriptive record by an observer. Still another observer is making an on-the-spot categorization of the child's questions and the mother's responses, and still another observer is recording the child's locomotor activity and his non-verbal exploratory behavior. Following the session we querry the child about the content of the room, the colors and locations of objects, etc. We hope to be able to relate information-seeking behavior during the play session to information possessed by the child afterward. Thus far, we have six mother-child pairs who have been observed in this situation, four of them on sound movie film. We will use the permanent movie record of these four sessions to devise codes, to investigate the reliability of coding, and to determine how much additional information is obtained by repetitive viewing of the mother-child interaction.

One of our methodological studies is devising a language for the observer to use in describing the mother-child interaction. This language is planned to be sufficiently restricted so that its content analysis can be programmed for a computer. There are a number of objectives for this development of a behavioral language. One of them is the need that we feel to record all of the behavior that takes place. In many studies where the child's behavior is experimentally controlled, the observers record only the particular behavior being manipulated. If the child's social interaction goes up from 15% to 60% we have no idea what kind of behavior was reduced or eliminated. We will attempt to manipulate children's information seeking behavior, but we feel that it is important to know what other kinds of behavior are changed if the frequency of questions is markedly increased. Therefore, we feel that a running record which attempts to record all of the behavior is an important source of data. There is, of course, a debatable question about whether a set of categories might not provide us with all the useful information, but it is our impression that the running record does contain more information than any pre-determined category system. If possible, we want to capitalize on this rich source of information.

One of the stumbling blocks to the use of such qualitative data has always been the trenendous amount of time required in transcription and coding of the running record. We believe it is essential, therefore, to find some procedure for speeding up the analysis of the record. It is our belief that we can teach the observer to speak in a restricted language. If not, we can train a translator to translate the observers running record into a restricted language. This restricted language is less ambiguous than is the natural language of the observer, but is rich enough that any particular item of information can be communicated in it. It is standardized enough that computer programs can be devised for its analysis. We are working at the moment to use a particular subset of the English language for which computer programs are about to be available. The output of the computer would be the deep structure of each of the sentences dictated by the observer. Since the same deep structure can underlie a variety of surface structures, this enables the observer to speak in a more or less natural form. In the deep structure, many of the characteristics of the sentence are specifically labelled. For example, if it is a question, there will be a marker of that fact. If it is a passive, there will be a marker of that fact. The deep structure already contains markers for many of the features of the sentence that we wish to analyze. Beyond that, then we must further devise programs for the content analysis of the sentences. For example, we can tell from the deep structure who was the object and who was the subject of each action. We still do not know whether this procedure for computerizing the content analysis of a running record is the most efficient, or whether grammars are sufficiently rich to permit the observer to say everything he need to say. We hope within a few months to modify the program in terms of our findings.

It is apparent from this report that the project is at its very beginning. We anticipate that these methodological problems will occupy us for a number of months, but eventually, once the observation and recording and analysis problems are resolved, we hope to introduce various kinds of experimental manipulations into the situations in order to study systematically children's information-seeking behavior, and how adult responses foster or discourage it.

THE CHILD'S KNOWLEDGE OF ENGLISH PLURALIZATION RULES

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This paper presents first a summary of some research Dick Tucker and I have completed under the sponsorship of Project Literacy. Following this, the implications of these findings for reading will be considered. In this research we tried to determine the extent of the child's acquisition of the standard rules of pluralization used by adult speakers of English. For speakers of English, the correct choice (excluding exceptional cases) of plural allomorph is determined by the final phoneme of the singular form of the noun. The allomorph /iz/ is added after sibilants and affricates; all other endings, if voiceless take /s/, and if voiced take /z/. These rules are exhibited daily in the child's linguistic environment, and our goal was to investigate to what extent the child has abstracted these implicit regularities. For this purpose we employed three production and three recognition tasks.

Method

Subjects.

The Ss were 36 kindergarten pupils with a mean age of five years 11 months. Half of the Ss were tested on the Production tasks and half on the Recognition tasks.

Production 1. Thirty-six pairs of pictures depicting cartoon animals were prepared. One member of each pair showed a single animal and the other a plural number of the same animal. For six pairs, S was first shown the singular picture, given its name (a nonsense syllable), and then requested to provide the proper name for the plural picture. For six other pairs, the procedure was reversed.

In this and in the following tasks the three allomorphs were equally represented.

Production 2. This task was the same as the preceding one, except that *S*s were asked to imagine animals without being given any pictorial stimuli.

Production 3. In this task, the second picture of the pair depicted the animal or animals preforming some action, and *S* was asked to describe the picture. *E* recorded only whether the appropriate form of the noun was used.

Recognition 1. In this task, *S* was shown *one* picture while *E* said a *pair* of nonsense names. *S* was instructed to choose the best name for the picture. Half of the pictures depicted one animal and the other half two or more.

Recognition 2. *Two* pictures, one depicting a single animal and the other several different animals, were shown to *S* while *E* said *one* name. *S* had to point to the picture named by *E*.

Recognition 3. A pair of pictures was shown to *S* while *E* said a *pair* of names. *S* had to point first to one picture as *E* again said the name, and then to tne other named picture.

Results

Analysis of variance for the three Production tasks revealed a significant difference among allomorphs (*F* = 9.23, *p* .01) and among tasks (*F* = 3.28, $p < .05$). The interaction was not significant (*F* = 1.33). The overall mean number of errors for Production tasks 1, 2, and 3 respectively is 2.56, 3.44, and 2.39. In each task, significantly more errors occurred with /ɨz/ than with either of the other two allomorphs. There were no significant differences between words with /s/ and /z/ in any of these tasks. Significantly more errors were found when the child had to produce the plural form given the singular, then when the task was reversed ($t = 2.50$, $p < .05$).

Analysis of variance for the three Recognition tasks revealed a significant difference between tasks ($F = 26.24$, $p < .001$) as well as a significant interaction ($F - 3.80$, $p < .05$); but the difference between allomorphs was not significant ($F = 1.83$). The overall mean number of errors for Recognition tasks 1, 2, and 3 respectively is 1.78, 2.78, and .18. No comparisons were possible within Recognition 3 because of the virtual absence of errors. In the other two Recognition tasks, significantly fewer errors occurred with /z/ than with either /s/ or with /ɨz/. There were no differences between errors with /s/ and with /ɨz/. No significant difference was found between number of singular and number of plural errors.

Discussion

The greater difficulty of the /ɨz/ marker in Production tasks can be attributed to its infrequency in the child's language and to the plural-sounding endings of singular nouns taking this allomorph.

The relative ease of /z/ in the Recognition tasks can be explained by reference to two facts about English: (a) Virtually all nouns ending in /consonant + z/ are plurals, but many singular words end in /consonant + s/ and in /vowel + z/, and (b) /z/ marks plurality for more words than /s/ or

/ɨz/. Thus, when a speaker of English hears a word ending in /consonant + z/ and has to decide whether it is a singular noun or a plural noun, his decision is much easier than in the case of /consonant + s/ or /vowel + z/. In the latter case, there are additional complications.

Implications for Reading

The following points are not direct deductions from our results. Rather, their relation to the findings is mediated through a general conception of mental operations supported by the present findings and consistent with other psychological evidence.

(a) It does not seem very fruitful to distinguish between receptive and productive control of grammatical rules in terms of levels of difficulty. Recognition task 2 is as difficult as any of the Production tasks, (The differences are not significant.) yet, it manifests a pattern of errors characteristic of the other Recognition Tasks rather than the pattern of the Production tasks.

Reading and writing, although certainly sharing some common processes, are not "the same thing in reverse."

(b) In performing a particular task, the speaker is not restricted to the information bearing directly on the task, but has access to and can utilize othere aspects of his linguistic knowledge. In carrying out a task involving singular and plural nouns, the children in our study apparently utilized statistical information which would not be included in any formal statement of pluralization rules.

The omnipresence of the totality of language is perhaps nowhere as obvious as in reading where pragmatic, semantic, synbactic, phonological, PRECEDING PAGE BLANK- NOT FILMED

and graphemic factors, in addition to sound-spelling correspondences, play important roles in the process of giving an oral interpretation to visual material.

(c) The problem of the undependability of English writing disappears if we conceive of reading not as a process by which the reader has to extract full information from the written material for correct oral rendition, but rather as a process involving the utilization of information to decide between alternatives. On this notion, reading is considered a hierarchical process of elimination of uncertainty. A comprehension of the structure of an utterance and knowledge of its topic of discourse impose broad limits on the perception of individual elements (say words) and eliminate a large number of alternatives. Within these broad limits, the number of possible renditions of a particular word would still be large. In order to reduce the alternatives to one, the reader will have to rely on the graphemic information present in the word. Here the reader will be best advised to examine first the letters richest in information, i.e., those capable of eliminating the largest number of alternative hypotheses, and to use the low information letters for deciding among the remaining alternatives. Using the criterion of amount of information, a natural dichotomy can be drawn between consonants and vowels. Consonants appear to be richer in information than vowels as evidenced by the greater impairment of comprehension resulting from consonant elimination than from vowel elimination. Moreover, consonants have more regular sound values than vowels and are therefore more dependable cues to reading.

If vowel letters were left to decide only those questions not answerable by the consonants, their "irregularity" would not constitute a problem. Often the information the vowel letter will need to yield in the decision process is only negative, i.e., what sound value it does not have rather than what sound value it does have. Stated somewhat differently, assume vowel letter "a" has three sound values designated X1, X2, X3 and "o" has three other values designated Y1, Y2, and Y3. It will often happen in reading that the reader will need to decide only whether the letter has a sound value belonging to the X family or the Y family; the particular value of X or Y can be decided on the basis of other information.

A STUDY OF SELECTED GRAPHEME-PHONEME CORRESPONDENCE PATTERNS

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Learning to read one's native language differs radically from learning to read a foreign language. For the latter task, that of reading a foreign language, the learner most frequently does not have any knowledge of the language he is to read and, in the majority of the cases, he desires to translate directly from writing to meaning. To the former task, however, the learner brings a reasonably adequate set of language habits, as evidenced by his ability to speak. Reading in this situation requires primarily the translation from written symbols to sound, a procedure which forms the basis of the reading process and furthermore, is probably the only language skill unique to reading. (Comprehension, for example, while a necessary criterion for reading, is a function of both speech and writing.) The primary concern of this paper is the teaching of this translation process; references hereafter to the teaching of reading, unless qualified otherwise, refer to spelling-to-sound translation only.

A good reader in the sense of this paper is one who can not only pronounce all of the words which he has been taught to read, but a high percentage of the new words which he encounters. Certainly a person who could do the former task -- that of pronouncing words he had seen before -- but displayed no ability to pronounce new words, would be classed as a deficient reader. Most literates form some spelling-to-sound generalizations regardless of the methods which they encountered in their initial reading instruction. What these generalizations are, how they develop and how they differ from one literate to another is at present unknown.

The rules presented in this and our two previous reports represent an ideal system for translating from spelling to sound, formed by assigning equal weights to each of the words used in the original corpus. It is inconceivable that any human could without special effort (like reading these reports) arrive at the same rules. Type-token relationships probably are highly influential in the formation of such patterns. The pronunciations of initial *ch*, for example, are irregular according to our results since no consistent cues can be used for selecting among (š), (k), and (č). The average literate, nevertheless, would most probably pronounce initial *ch* in a strange word as (č) simply because most of the frequently occurring words with initial *ch* are pronounced with (č).

Which of the major patterns are learned by literates is not known -- in fact, extremely little is known about the extent of generalization in this area. Furthermore, there has been so little discussion of this process that no clearly defined criteria for generalization have been formulated. In the *ch* pattern cited above, for example, what would good generalization be? To pronounce all new initial *ch* words with (č)? To pronounce X percent with (č), Y percent with (š), and Z percent with (k), where X, Y, and Z correlate to the frequency of known initial *ch* words with the different pronunciations? Or what? If the teaching of reading is to be placed on a more substantial foundation than it now occupies, then the nature and goals of reading generalization must be explored.

Once the reading habits of literates are known and attainable goals for reading established, some of the sacred cows of reading instruction could be re-examined. The first of these to undergo inspection should be the notion of sequencing materials from the simple to the complex, the heart of the Bloomfield approach and of almost all of the new "linguistic" approaches to teaching reading. While such an approach may, with sufficient experimentation, prove to be more efficient than any other possible approach, there is little linguistic or psychological support for it at present.

For example, understanding one of the most important spelling patterns, that of the correspondences for the primary vowel spellings requires differentiation of both graphemic environments and responses. The letter *a*, as an example, has two primary pronunciations in stressed position, /ae/ and /e/. The checked alternative, /ae/, occurs when *a* is followed by a final consonant or by a series of consonants, as in *rat* and *annals*. In addition, it occurs when *a* is followed by a single consonant plus one of several possible suffixes, like *-ity* (e.g., *sanity*). The free pronunciation, /e/, occurs when *a* is in the other graphemic environments, like *rate*, *anal*, and *sane*. What must be acquired for the proper pronunciation of *a* is the ability to differentiate the environments and suffixes; final consonant vs. consonant plus final *e* (*rat*:*rate*), double medial consonant vs. single medial consonant (*annals*:*anal*), and the base form vs. particular suffixes forms (*sane*:*sanity*).

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The Bloomfieldian sequencing begins with the /æ/ pronunciation for a, introducing the /e/ pronunciation at a later time with no special emphasis on the relation between /æ/ and /e/ when derived from a. An alternative to this approach is to present both pronunciations at once, working with such pairs as rat:rate, mat:mate, fat:fate, hat:hate and man:mane. Both the associations of a to /æ/ and a to /e/ and the discrimination of the graphemic environments would be emphasized. Whether or not a child first learning to read can handle this task probably depends upon the pedagogy employed. The potential generalization derived from the differentiation approach, however, certainly is greater than that from the simple-sequence method.

There are other areas where we feel new techniques could be introduced, such as in emphasizing the relational unit-marker dichotomy, but we feel that the task ahead in reading research should be primarily in the hands of the psychologist. While several patterns uncovered in our work need further work, we feel that the spelling-to-sound structure which we have presented is detailed enough to form the basis for a study of human reading habits. The first goal of such research should be to uncover the extent of spelling-to-sound generalization in so called good readers. The next steps would be to study the development of the generalization habits which do exist and to develop methods for teaching the ones that do not exist, but are deemed necessary for good reading.

ON THE INTERACTIONS OF MEMORY AND PERCEPTION

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The work to be reported has as its ultimate goal the specification and quantification of the effects of memory on perception. It is particularly concerned with the effects of those aspects of memory which may be associated with the relatively long lasting structures built up over the course of long-term exposure to meaningful (symbolic) visual stimuli. For example, the memory correlate of the concept of "form" or "triangularity" might reasonably be thought to alter the perception of these figures after prolonged (over many years) exposure.

In order to assess these effects, a specific class of forms has been selected. These forms, the letters of the alphabet, provide an opportunity to evaluate quantitative effects as well as qualitative ones by permitting variation in combination of forms so as to approximate more and more closely the structures already in memory. That is, by combining the letters of the English language in various ways, distributions may be generated which vary consistently in their approximation to the letter frequencies and sequential probabilities of the English language and inferentially to the memory correlates of these distributions.

The memory component of this interaction, then, may be called cognitive structure, to differentiate it from structure in the stimulus. In the research to be reported cognitive structure remains constant--that of the English language gained over the lifetime of the organism. The significant independent variable is stimulus structure--approximation to the letter frequencies and sequential probabilities of English.

The dependent variable is the perception of the letters presented. This must be inferred from the observer's verbal report of what he sees. Thus, since perception must be inferred from verbal report, it is possible for mechanisms other than perceptual to intervene between percept and report of percept. Various manipulations must be introduced to control for such effects (e.g., memory decrement during rehearsal and before report) or to minimize them.

Experiment 1

Hershenson and Haber (1965) have shown that English words were more easily perceived than Turkish words. The words of the two languages were assumed to have equivalent structural characteristics so that the effect was most likely due to the differential availability of cognitive structures related to the two languages. In the present study, stimulus structure was varied while cognitive structure was held constant. The unstructured stimuli, random letters, should yield results similar to those of structured stimuli having no cognitive counterpart, such as Turkish words. Moreover, perceptibility should be a function of approximation to English--to cognitive structure--with the English words the most easily perceived and the random letters the most difficult to perceive.

Method

Stimuli. Seventy English words were randomly selected from the 504 of Haber and Hershenson (1965) which represented virtually the population of 7-letter, 3-syllable words that appear not infrequently in print. In addition, four lists of 70 7-letter arrays of each of zero, first, second, and third order approximations to English were constructed according to a procedure described by Shannon (1948). Each stimulus "word" was lettered in black on a white card and in all respects conformed to the stimulus dimensions of Haber and Hershenson (1965).

The stimuli were presented in one channel of a three-channel mirror tachistoscope (Scientific Prototype Mfg. Corp., Model GA). A second channel, serving as an adapting field, contained two faint lines for fixation boundaries. The S initiated each trial by pressing a button when he felt he was giving maximal attention to the proper fixation point. The reflectance, measured at the eyepiece with a Mcbeth Illuminometer was 95 ml. for both stimulus and adapting field.

Procedure. Ten "words" in each of the stimulus lists were assigned to each of seven trial numbers (1, 2, 3, 4, 10, and 15) representing the number of times it would be flashed. Seventy words were presented in each of five sessions; two at each of the 35 list-by-trial-number combinations. The words were presented in random order within sessions. The sequence of presenting the five sets of words was randomly determined for each S. Interflash interval was never less than five seconds.

The S's were trained to report letters rather than words in two practice sessions preceding the experiment. Lists of English words with one letter missing were flashed and S was required to report the letters that he saw on each exposure. Thus S's performance could be monitored via reports of missing letters. Few incorrect responses were made.

The duration to be used for each S in the experiment proper was determined during these practice sessions by continually adjusting the exposure duration of the practice words until a value was found such that S reported few letters on the first flash but correctly reported all the letters (and the correct missing letter) on some subsequent trial.

In all experimental sessions, S reported after each flash both the letters he was certain he perceived and their respective positions even when, in the case of English words, he was certain of the word. At no time was S given information as to his accuracy. Nor did he know at the time he was reporting whether there would be further trials for the same word.

Subjects. The S's were 11 male undergraduate students enrolled in an elementary course in perception at the University of Wisconsin. They had not previously served in a perception experiment and were not aware of the nature of the experiment at the time of testing. Each S was tested individually in seven 1-hour sessions.

Results and Discussion

Stimulus structure. The percentage of letters correctly perceived was a function of the levels of approximation to English ($p < .01$). Moreover, the curves line up as predicted with English words the most easily perceived, random letters the least easily perceived, and the others at the appropriate intermediate levels. By correcting the percent-correct scores for redundancy (estimated in percentage) of the various approximations to English (Miller, Bruner, & Postman, 1954), we may calculate the amount of information perceived or transmitted. Once again we see a gradual increase over trials for all levels of approximation to English, but the order of the curves is exactly reversed, with no overlap--the information perceived decreases the closer the approximation to English and is least for actual English.

Exposure trials. All curves measuring percent "words" correct over 15 trials and percent letters correct over the first five trials increase as a function of repeated exposures for each of the five lists of words. Thus microgenetic development over trials appears to be independent of stimulus structure.

Error analysis. An analysis of errors by letter position indicates that there is a slight deficit for letters presented to the right of the fixation point. This effect may be perceptual, or attentional, or may be a memory loss due to order of report. While this effect interacts with amount of stimulus structure, the overall effects of structure do not appear to be altered.

Distributions of letters correctly perceived, letters confused--those stimuli for which errors were made, and letters guessed--the actual incorrect responses made were analyzed in further detail by correlating them among themselves for each approximation and within each trial. They were also correlated with five other distributions: three distributions of visual confusability (VC)--one objective and two subjective, a measure of auditory confusability (AC) and a measure of English frequency (EF). The letters correctly perceived showed a low negative correlation with VC consistently in all cases and no correlation with AC or EF, suggesting that when a letter was correctly reported it probably had been perceived. This is further supported by the lack of a correlation between correct and correct for different trials. That is, the letters correctly reported were predominantly a function of the stimulus.

The distributions for letters confused correlated highly among themselves and also highly but negatively with EF. Together with the low negative correlations with AC and low positive correlations with VC, the confusions were probably visual rather than auditory. Furthermore, it

Page misnumbered

suggests that memory was not at factor, if it is assumed that visual memory for letters has an auditory rehearsal component. It is not clear, however, why the most frequently confused letters were the letters least frequent in English.

The letters guessed also correlated highly among themselves. There was also a low correlation with VC, no correlation with AC, and a high positive correlation with EF. Therefore, when S did not see a word, he guessed, and his guesses took the form of the distribution of EF. This clearly is a response process.

It is clear that the cognitive structures reflecting the statistical properties of the stimuli contributed to the ease of perception of the "words." This may be taken to represent a general property of the perceptual system and further illustrates a perceptual-memory interaction component which should be taken into account in our understanding of the processes underlying "seeing" words, i.e., learning to read.

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THE ROLE OF PRONOUNCEABILITY IN PERCEPTION OF PSEUDO-WORDS BY HEARING AND DEAF SUBJECTS

Eleanor J. Gibson, Arthur Shurcliff, & Albert Yonas

For more than half a century, we have known that a good reader does not read sequentially, letter by letter, but takes in and processes larger graphic units (Cattell, 1885). Yet, except for the obvious surmise that a familiar word constitutes a unit, there has been little research or even speculation on the relevant grouping principles. How are larger graphic units constituted? As part of an inter-disciplinary program of basic research on reading, we developed the following hypothesis, influenced by the work of Dr. Charles Hockett. Hockett worked on the problem of how English spelling patterns are mapped to sound, and convinced us that English spelling is not totally irregular in its correspondence with speech sounds, as is sometimes asserted, but that the rules are there if higher graphic units than the single letter are considered.

Beginning with the assumption that units for perception (as in object constancy) are determined by some invariant stimulus property characterizing an otherwise heterogeneous array, we proposed that units for reading are formed by a relatively invariant mapping to sound. For English spellings this would mean that letter clusters in a given position in a word and in a given environment, when they map with regularity to pronunciation, will operate as units, and that grouping is functionally determined by the relationship to speech sounds.

That the reader is not aware of mapping rules from spelling to speech need not mean that order and regularity are not extracted and used in the course of learning to read. As Venezky and Weir (1966) have shown, the rules are indeed "high level" ones and a long program of computer-aided research was required to formulate them. The question is, does the skilled reader, knowingly or not, actually use them in processing written language?

We tried to answer this question with an experiment in which pseudo-words--that is, letter-strings which were not real words, but which in some cases might have been--were presented tachistoscopically to skilled readers of English. The words were all monosyllables, consisting of an initial consonant cluster, a vowel cluster, and a final consonant cluster. Half of them were constructed so that the initial consonant cluster had a single regular pronunciation in that position, the final one in its position and the vowel cluster a regular pronunciation when preceeded and followed by the selected consonant clusters. These were called the pronounceable words. A control set of words was constructed from the same letters, but with the initial and final consonant clusters reversed, rendering them relatively unpronounceable. For instance, a pronounceable pseudo-word was GLURCK; its unpronounceable counterpart was CKURGL.

This experiment was run and replicated several times (Gibson, et al., 1963) and very consistently gave significant results in the predicted direction. In the meantime, several theoretical questions were brought up by members of the research group as to the exact interpretation of the results. What did pronounceability really mean? Was it actually the invariance-to-sound-mapping that was crucial? Partial answers to these questions were sought in the two following experiments. All the words were rated for pronounceability on a 9-point scale (see Underwood and Schulz, 1960). The words constructed to be pronounceable were indeed rated so, their counterparts not. Second 16 subjects were asked to read aloud all the words and their pronunciations were recorded on tape. The pronunciations were analyzed by two linguists and the variability of pronunciation determined for each word. It was as predicted, and correlated .83 with the pronounceability rating.

The results were published at this point, and soon afterward several alternative interpretations were suggested. In all, five different interpretations appeared to warrant consideration or at least an answer. They are as follows:

1. Rules of spelling-to-sound mapping suggest that mapping-invariance creates larger units for reading and therefore faster processing (original hypothesis described above).

2. Transitional probabilities in written English, without regard to sound, account for the superiority of the so-called pronounceable words. It was suggested (Anisfeld, 1964) that summed bigram or summed trigram counts would predict the results obtained in the experiments. These counts were not significant, but the correlation between pronounceability rating and number correctly perceived was.

3. Pronounceable words are more readily perceived because they "match" to an acoustic representation. When a word (or letter-string) is exposed, it is silently rehearsed and matched with a stored auditory representation (Levin & Biemiller, 1965). This hypothesis implies auditory encoding before final reading.

4. Processing of letter-strings in reading involves encoding and matching to an articulatory representation or "plan." (cf. Liberman, et al., 1963)

5. Complex morphological rules cover structural patterns of letters permissable in English words. Such rules are not merely transitional probabilities but are a kind of syntax, analogous to grammar. Such rules could be learned, as one learns to read, with or without relating them to speech sounds. (An obvious example is the case of consonants or consonant clusters which cannot be used initially but can finally, and vice versa; used in construction lists in the present experiment.)

The Experiment

Because a resolution among these alternatives would have important implications for teaching reading, experiments were sought which might decide among them. A comparison of deaf and hearing subjects, it was thought, should be revealing, especially when various potential predictor variables were weighed against performance with pronounceable vs. unpronounceable words. Accordingly, the original experiment was modified slightly for replication with deaf subjects. All instructions were written, lights used as ready signals, and so on. A new control group of hearing subjects was run as well.

Subjects were secured at Gallaudet College for the Deaf in Washington, where both staff and students cooperated in every possible way. We requested subjects who were congenitally deaf, or nearly so, and who had maximal hearing losses. Thirty-four subjects were run in small groups of three or four. The staff furnished for the Ss hearing ratings, speech ratings, age of onset of deafness, and scores on various tests such as reading and verbal aptitude. At the close of the experiment, the subjects themselves answered questionnaires regarding the way they were taught to read.

The results of the experiment are presented primarily in two tables of correlation matrices. Mean errors for the two groups are not included, so it is worth noting here that the deaf subjects, in general, made significantly more errors than the hearing subjects ($M = 37.09$ compared with 26.20). However, looking at the correlations in Table 1, it is clear that pronounceability is significantly correlated with perception of pseudo-words for the deaf Ss as well as for hearing Ss.

The correlation matrix in Table I was subjected to two multiple regression analyses. Predictor variables selected for one analysis were word length, summed bigram frequency, summed trigram frequency and pronounceability. Beta weights (Beta prime) for the value of these variables in predicting errors are shown below in Table 3. It is clear that a multiple regression using these four variables to predict error has significant contributions from word length and from pronounceability, but none from either frequency count (in fact, trigram frequency detracts from the prediction).

Table 3

Beta Weights (Beta Prime)

	Hearing Ss	Deaf Ss
Length	.74	.66
Pron.	.33	.44
Pigram frequency	.03	.01
Trigram frequency	-.11	-.02

In a second multiple regressson analysis, five variables were included as predictors of error-length, pronounceability, the Mayzner Trigram and Bigram Counts (see Mayzner, et al.) and agreement (number of pronounciations). Table 4 below gives the Beta Weights for these variables. Again, length and pronounceability predict errors significantly, whereas the other three variables do not. It is notable that pronounceability predicts, if anything, better for the deaf subjects. The fact that the Mayzner counts are no better than mere summed bigram and summed trigram frequency is interesting in view of the fact that they take position of the bigram or trigram in the word and word length into account. Pronounceability ratings are clearly measuring and predicting something that none of the frequency counts gets at.

Table 4

Beta Weights (Beta Prime)

	Hearing Ss	Deaf Ss
Length	.73	.60
Pron.	.38	.64
Mayzner Trigram count	-.08	-.16
Mayzner Bigram Count	-.036	.02
Agreement	-.10	-.32

An examination of Table 2, which gives correlations for a number of variables for the deaf subjects does not reveal much. A stepwise regression analysis of this matrix revealed that hearing rating alone was a significant predictor of errors, and that only at about the 5 percent level of significance.

Nothing else added significantly to the multiple regression. The fact that hearing level, even very low (and they all were) has any predictive value at all may seem odd in view of the correlation between pronounceability and errors for the deaf subjects, but it probably reflects the fact that more exposure to education in general is facilitated by even a little hearing.

Interpretation

Now, to return to the five hypotheses, can we eliminate any on the basis of these data? I think we can. First, consider sequential probabilities. All four of the frequency counts taken in the present study are powerless in predicting errors. Furthermore, in a quick factor analysis (McQuitty's Elementary Linkage Analysis) the four frequency counts fell neatly in one cluster, the other variables in another. Sequential probability, insofar as it is reflected in any presently available frequency count, is not a critical predictor.

Secondly, consider the theory that a word is matched to an acoustic representation before it is read. This is obviously impossible for the deaf Ss. Even those who were rated highest in hearing were unable to discriminate speech sounds.

Thirdly, consider matching to an "articulatory plan." Again, this seems manifestly impossible for the deaf Ss. Most of them did not speak, and speech rating (its comprehensibility and therefore differentiation) did not predict errors.

Fourthly, consider the hypothesis which inspired our first experiment--that spellings which map with invariance to sound become "chunks" or larger units. With the greatest reluctance, we admit this hypothesis is seriously weakened. The fact that the deaf Ss were equally or indeed more facilitated in reading pronounceable spellings must mean that the mapping relation to sound is not essential--or rather, that it is not essential for the reader to experience the cross-modal invariance.

In another sense, however, the cross-modal invariance is essential. It is essential in the evolution of written language. Our fifth hypothesis was that pronounceability ratings are measuring morphological regularity (rules governing the internal structure of English words), and that it is this kind of structure in the pronounceable words that facilitates perception. The words are rated pronounceable, because the writing system--and therefore morphological rules--evolved in relation to sound. Therefore pseudo-words that follow the rules must map to sound with regularity and must be rated pronounceable.

Writing is a surrogate for speech; but morphological rules are rules in their own right, and apparently can be learned as such, quite aside from the fact that any word they produce maps predictably to speech sounds. Sound would seem thus to be not necessarily a part of the individual's processing in forming higher units of reading, although historically it formed them in the spelling patterns of the written language. This conclusion finds support in Venezky and Weir's work on relation of spelling to sound. They found it necessary to develop a model for mapping first from spelling onto a morphophonemic level and then to sound. "The orthography," they said, "fits more snugly into a morphophonemic model than into a direct spelling-to-sound one" (1966, p. 3). It would appear, from the data reported, that the morphophonemic regularities available to the deaf reader are adequate for the formation of units even when the sound correspondence is not directly available to him.

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Table 1

Correlations betwen Errors for Pseudo-Words and Various

Predictor Variables (Hearing and Deaf Ss)

	Length	B.F.	T.F.	Pron. Rating	Hear Errors	Deaf Errors	M.T.F.	M.B.F.	Old Data	Agreement
Length	1.0	.64	.21	.35	.85	.82	-.02	.07	-.84	.04
Bigram Frequency		1.0	.73	-.03	.41	.41	.31	.55	-.43	-.17
Trigram Frequency			1.0	-.14	.02	.06	.28	.75	-.08	-.16
Pronounc. Rating				1.0	.61	.68	-.63	-.44	-.61	.83
Hearing Errors					1.0	.93	-.29	-.16	-.91	.30
Deaf Errors						1.0	-.37	-.21	-.96	.32
Mayzner Tri. Frequency							1.0	.65	.43	-.59
Mayzner Bigram Frequency								1.0	.20	-.37
Old Data									1.0	-.27
Agreement (No. of different pronunciations)										1.0

Table II

Correlations between Errors for Pseudo-Words and Various

Predictor Variables (Deaf Subjects Only)

	Errors	Hearing	Speech	Onset	SCAT Verbal	STEP Reading	SRA Verbal	Vocat.	SRA Nonverbal
Errors	1.00	.44	.32	-.24	-.04	-.31	-.37	-.25	.23
Hearing Rating		1.00	.53	-.31	.09	-.16	-.23	.04	.04
Speech Rating			1.00	-.43	-.22	-.54	-.23	-.23	-.01
Age of Onset				1.00	.05	.21	.05	-.10	-.17
SCAT Verbal					1.00	.32	.27	.54	.08
STEP Reading						1.00	.39	.70	.15
SRA Verbal							1.00	.54	-.24
Vocabulary								1.00	.04
SRA Nonverbal									1.00

PERCEPTUAL "CHUNKING" AND STORAGE IN READING WORDS

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Although it has been asserted for centuries that our perception of objects' shapes are learned, there has been remarkably little unequivocal demonstration of effects of learning on the perception of shape, and until recently, even less experimental inquiry into what changes of the perceptual process are responsible for those effects, if any.

Here are two major alternatives on this issue:

One: The basic receptive processes might themselves be altered by perceptual learning and thereby the nature of what will be an adequate stimulus, might change.

Two: The receptive processes, and some associated perceptual phenomena, might remain untouched (i.e., there might be basic and relatively inalterable form-perception mechanisms inborn, or established early in the individual's life). Any changes that might be expected to occur, through learning, would then have to consist only of changes in the organism's deployment of attentional eye-movements, on the one hand, and in the ways in which each glimpse of the world is remembered, on the other hand.

I shall argue here that the evidence more closely supports the second alternative -- that is, that the effects of perceptual learning consist of changes in where you look, and of how you remember what you saw, and not of changes in what you see in any individual momentary glance.

I shall restrict my discussion to the perception of printed text, but most of what I shall say applies just as well to the perception of pictures of objects and of people.

It is easy, as you might expect, to demonstrate that children make different kinds of eyemovements while reading, after they have learned to read well, since they now have to look fewer times at any word in order to recognize it. This fits Cattell's old observation that while only a few unrelated letters can be recognized in a brief tachistoscopic exposure, a great many more letters can be recognized if they form some familiar word. As a result of having learned to read, the letters in a familiar word now appear to be processed in larger chunks. This seems to be clear effect of learning on perception, and many experiments have been done since with similar results: that legible letters have lower tachistoscopic thresholds for recognition than their illegible mirror images; that pronounceable nonsense syllables have lower tachistoscopic recognition thresholds than do unpronounceable one; that familiar words have lower tachistoscopic thresholds than do unfamiliar ones.

Thus, learning to read clearly appears to affect the tachistoscopic recognition or identification of text. But does learning affect the way we see the words -- that is, the way we pick up their forms, initially, -- or does learning to read only alter the ways in which these forms are stored and remembered?

Consider first the following series of experiments:

Series I

In all of the first series of experiments, subjects were presented with two sets of letters, which I shall refer to as a pair of "words" (even though they were often meaningless and unpronounceable). The subjects' task was to say whether the two members of each pair were the same or different, which they were on half the trials. There were two conditions of comparison, "direct" and "indirect."

(a) Direct or simultaneous comparison.

In this condition, the two words were close together, either as a double column, or as a double row; in either case, the corresponding letters in each words were next to each other. This direct procedure demanded least of the subjects' memory.

Each word might either be meaningful and pronounceable by both adults and children; pronounceable only by adults; or meaningless and unpronounceable. They might be printed in normal legible orientation, or in reversed illegible orientation. Both members might be upper case, or one might be in upper case, one in lower case.

In this direct condition of comparison, the results were as follows: Whether the words were meaningful or not; whether they were the same, or not; whether they were illegible mirror images, or were normal type -- none of these factors has any effect on the time taken, or on the number of glances needed, to decide whether the words were same or different. Only one condition hindered performance: When one word was printed in capitals, the other in lower case -- that is, if the two words differed in form, even though they might have the same spelling -- now, performance time increased significantly for all subjects.

These results suggest two things:

First: Within some obvious limits, the perceptual learning due to having learned to read, did not enter into this performance.

Second: When corresponding letters differed in shape (that is, when one word was in upper and one in lower case,), then performance time increased, because subjects could not then simply compare the two words' forms. That is, the letters now had to pass through a decoding stage, one in which different shapes are equivalent in meaning, in order to decide their sameness or difference. This point is important in interpreting the results of the next condition of comparision.

(b) Indirect or successive comparison.

Subjects compared two words which were separated horizontally by about 20°. Since both words could not now be seen foveally with one fixation, the subject had to look back and forth, consulting his memory of at least one of them.

Otherwise, the procedures were the same as in the previous experiments. Now, however, the effects of learning and familiarity became very evident:

When the words are illegible mirror-images, they take more time; when they are unpronounceable by the subject, they take more time. With familiar words, one or two fixations suffice to decide whether the words are same or different; with illegible or unpronounceable letters, subjects have to look back and forth, comparing the two words almost letter by letter.

On the other hand, it now makes no difference whether the words are of the same shape (i.e., both capitals) or of different shape (capitals and lower case): comparison times remain substantially unchanged.

There two sets of experiments -- simultaneous and successive, or direct and indirect comparison -- thus have diametrically opposite results. What do these differences mean? To me, this seems to argue strongly that the learned ability to recognize words as chunks, resides in the formation of the appropriate units in encoding and storage, not in any changes in the immediate processing of form.

Now, if this is true -- if visual form pick-up remains unchanged by reading experiences -- that we should be able to demonstrate that some appropriate phonomenon that is dependent on form, other than form-recognition itself, also remains unchanged. I have chosen apparent motion as the form-dependent phonomenon with which to test this in the second series of experiments, and the results are fully consistent with the above conclusion:

Series II

In the following sets of experiments, the two words were projected for 1 second each on the same spot on a screen, successively, with a variable inter-stimulus interval between the two. Again, subjects had to say whether the two words were same or different. At a short interstimulus interval (s0 to 150 msec.), any difference between the words showed up as apparent movement, and was detected in one or two cycles of presentation -- regardless of whether the words were familiar or unfamiliar, legible or illegible, pronounceable or unpronounceable. However, when one word was in upper case and one was in lower case, many cycles were required to make the judgement; the reason for this was obvious -- apparent motion occurred even when the two words had the same spelling, since their forms were different -- and parallel the similar effects that type-face difference had in the corresponding experiments of Series Ia.

If we increase the interstimulus interval, say to a second, the results are reversed: now, it makes no difference whether the words are in the same type face or not, but their legibility and their familiarity become crucial. With familiar words, the same-difference judgement may take one or two cycles, while a meaningless or illegible word-pair may require a dozen cycles, as the subject compares the first two letters of the successive presentation, the next two letters, etc.

Summary

The effects of perceptual learning on word-recognition seem to be effects on memorial and storage phenomena, not effects on the initial reception of form as measured by direct form-difference judgements, or by a form-dependent phenomenon (apparent motion). Something very like the old Structuralist distinction between innate sensation and learned perception would seem plausible at this time, in this sense: there seems to be a hierarchy of susceptibility to the effects of learning, and a discontinuity between the processing of simple form, on the one hand, and of higher-level or derivative processes, on the other. In any event, theories of reading-learning cannot be based on assumed changes in simple form reception, on the basis of present evidence, and the effects of reading learning seem to start with the formation of the appropriate storage units.

SENTENCE STRUCTURE AND THE EYE-VOICE SPAN

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Early studies dealing with the eye-voice span have shown a number of factors have an effect on the span. Some of the factors which have been found to be important are general reading ability, subject age, position in line of reading, difficulty of passage, and contextual constraint. In one of these early studies, it was found that the position within the sentence has a stronger effect on the eye-voice span than the position within the line. One explanation might be the predictability of what comes next tends to increase from the beginning of the sentence to the end and affects the eye-voice span. Also, it might be that the grammatical structure of the sentence has an effect. In support of this conjecture Tinker suggested recently that reading is in terms of units of groups of words, and Schlesinger wrote that "the span of the eyes ... ahead of the voice represents a unit of decoding." He predicted that the units of reading could be defined in terms of syntactic structure. Subjects were predicted to read ahead to the end of a group of words which could exist alone as a unit or phrase, and his results supported this hypothesis. However, the exact nature of his stimulus materials is unclear.

The present study is designed to investigate the developmental effects of sentence structure on the eye-voice span of the reader. We hypothesize that the eye-voice span is not a constant or fixed length regardless of the material being read, but that it is affected by the grammatical structure of the material being read, among other factors.

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Method

Subjects. Ten Ss at each of six grade levels were used; the grade levels were second grade, fourth grade, sixth grade, eighth grade, tenth grade, and adults. The adults were Cornell University freshman and sophomores; the remaining subjects came from the Dryden Elementary School and the Dryden High School.

Stimulus materials. Four types of sentences were used:

1. Active sentences made up entirely of two-word phrases.
2. Active sentences made up of three-word phrases.
3. Passive sentences made up of three-word phrases.
4. Active sentences made up of four-word phrases.

The number of sentences within each of the four types was such that the light could be turned off at all possible between-word points in the first two phrases. The light was turned off an equal number of times before and after the first major immediate constituent (IC) cut of the sentence. Table 1 shows the design for the two-word phrase sentences:

Table 1

Positions of Light Out for Two-word Phrases

First Major IC

/ 1	2	3	4	‖	5	6	7	8
1	/ 2	3	4	‖	5	6	7	8
1	2	/ 3	4	‖	5	6	7	8
1	2	3	/ 4	‖	5	6	7	8
1	2	3	4	‖	/ 5	6	7	8
1	2	3	4	‖	5	/ 6	7	8
1	2	3	4	‖	5	6	/ 7	8
1	2	3	4	‖	5	6	7	/ 8

A different sentence content was used for each of the light-out positions. Thus there was a total of eight two-word phrase sentences, 12 three-word active sentences, 12 three-word phrase passive sentences, and 16 four-word phrase active sentence. In addition, there were eight structureless word lists, making a total of 56 sentences.

Sentences were constructed with enough phrase units in them so that there would always be at least ten words in the sentence beyond the light-out position, so that the light tended to be turned off toward the left hand side of the sentences. Each of the critical sentences was embedded in a paragraph of four sentences. The critical sentence occurred an equal number of times in the first, second, third, and fourth sentence position. A random order of presentation of sentences was used; the same order was used for each subject.

Two similar sets of sentences were used. One set was made up with the vocabulary of the second grade reader and was used with second and fourth grades; another set was made up with the vocabulary of a sixth grader and was used with the sixth grade and all older subjects.

Apparatus. A wooden box (24" X 18" X 12") with a slanted front surface in which there was a one-way mirror was used to present the stimulus sentences. It was so designed that S could only see through the mirror and read the sentences on the cards when the light inside the box was turned on. A micro-switch was used to turn on the light inside the box. When the E released the micro-switch, the light inside the box turned off. A timer was also connected to the apparatus so that the clock started when the light inside the box was turned on and stopped when the light inside the box was turned off. Thus the timer measured the time taken by a S to read from the beginning of a passage to the light-out position.

Procedure. The S was seated in front of the apparatus and was told to focus on a red dot on the one-way mirror which was the point where the beginning of the paragraph appeared when the light was turned on. The S was told to read at his normal rate or the rate at which he would read a storybook out loud. When the light inside the box was turned on, S began to read aloud the passage in front of him; when the light went out, at a predesignated position, S was told to report all the words he had seen beyond the word or words he was uttering when the light went out. All the words reported by the subject were recorded. The time taken by the subject to read to the point at which the light was turned out was also recorded in an attempt to get some measure of subjects speed of reading.

Scoring. The number of consecutive words which each S reported having seen beyond the light-out position was recorded for each sentence as a measure of his eye-voice span for that sentence. In addition, the number of times S reported having read ahead to the end of a phrase versus to a non-phrase position was recorded. Readers were divided into two groups, slow and fast readers, on the basis of whether their time scores were below or above the median, respectively.

Results

Length of Eye-voice Span. A comparison was made between the mean length of the eye-voice span on the unstructured word lists and on the structured sentences. The difference in the eye-voice span for these two types of reading material was found to be significant at .001 level ($t = 6.17$, $df = 38$, two-tailed test). Table 2 shows the mean eye-voice span for each of the six grade levels for slow and fast readers; Table 3 gives the mean EVS by grade and lengths of phrase units. A three-way analysis of variance (Grade, Speed of Reading, and Length of Phrase) with repeated measures was carried out on the length of the eye-voice span. The main effect of Grade Level was found to be significant at the .001 level ($F = 10.85$, $df = 5/48$) and the main effect of speed of reading at the .001 level ($F = 25.96$, $df = 1/48$). The effect of length of phrase unit was not found to be significant with respect to mean eye-voice span.

Table 2

Mean EVS for Fast and Slow Readers

Grade	Fast Readers	Slow Readers	Σ
	STRINGS		
2	3.64	2.78	3.21
4	4.50	4.32	4.41
6	3.12	2.12	2.62
8	4.92	3.42	4.17
10	4.20	3.70	3.95
Adult	5.40	4.64	5.02
	WORD LIST		
2	2.10	1.70	1.90
4	2.46	2.40	2.43
6	1.72	1.12	1.42
8	2.60	1.62	2.01
10	2.10	2.10	2.02
Adult	2.90	2.76	2.83

Table 3

Mean EVS by Length of Chain and Age of Ss

Grade	2 word chain	3 word chain	4 word chain	Word List
2	3.16	3.18	3.27	1.89
4	4.24	4.72	4.27	2.42
6	2.48	2.94	2.56	1.42
8	3.99	4.47	4.09	2.01
10	2.79	4.37	3.66	2.02
Adult	4.91	7.42	4.74	2.83

Unit versus Non-unit reading. In order to test whether there was a significant tendency for subjects to read to the end of a phrase, the number of times each subject read to the end of a phrase on each of the sentence types was recorded. This score was corrected for any tendency of subjects to read ahead to the end of a phrase only when the phrase boundary fell at the end of the subjects's eye-voice span. The number of times a subject read to the end of a phrase with his two consecutive most frequent eye-voice spans (in other words his modal eye-voice span) was subtracted from the overall total. If it were the case that subjects tended to read to the end of phrase units only when their modal eye-voice span ended there, then the sum of all the scores computed as described above should be zero. The overall mean number of times subjects read to phrase boundaries was 8.20 which was found to be significantly greater than zero ($t = 16.73$, $df = 59$, $p < .001$).

An analysis of variance of the number of times subjects read to phrase boundaries was carried out for subject grades, reader speed, and phrase length. The main effect of subject grades was significant at the .005 level (F = 4.28, df = 5/48); reader speed was significant at the .01 level (F = 8.57, df = 1/48); and phrase length was significant at the .01 level (F = 21.96, df = 2/96). No interaction was found to be significant.

In addition to the 492 times subjects read to phrase boundaries when the phrase boundary was not at the modal eye-voice span length, subjects changed the sentence structure and content 107 times so that they read to the end of a phrase unit even though this was not actually the case.

Discussion

The results of the present study supported the hypothesis that subjects tend to read in units or phrases and not with a fixed eye-voice span. Subjects tended to read to the end of phrases boundaries on all types of sentences and the overall phrase-boundary score corrected for the modal eye-voice span was significant.

The hypothesis that subjects tend to read in terms of phrase units was further supported by the finding that not infrequently subjects tend to make up unit or phrase endings if they didn't actually see ahead to the end of the unit.

The eye-voice span tended to increase with age. The sixth grade subjects tended to deviate from this trend. This was probably due to the fact that the subjects in the sixth grade were, on the whole, relatively poor readers, while the subjects from the second through tenth grades were from better reading groups, for the most part.

Subjects who tended to read rapidly, in spite of the "read at your normal rate of speed" instruction, tended to have longer eye-voice spans and to read to phrase boundaries more frequently than the subjects who read more slowly. This suggests that the better readers tend to read in terms of chunks or units of grammar and content.

WHAT IS PROJECT LITERACY?

Project Literacy was organized at Cornell University on February 1, 1964, by a developmental projects award from the Cooperative Research Branch of the United States Office of Education. This project represents one of the major commitments of the Office of Education to basic research and curriculum development concerning both child and adult literacy.

The purpose of Project Literacy is to organize, in various universities, laboratories and state departments of education, research which is essential to understand the acquisition of reading skills. The major initial effort is to bring together researchers and educators from a variety of disciplines to plan research which, when taken as a whole, will give us more substantial results than any single study can provide. Each investigator in the research consortium will be completely responsible for his own activities. The project will provide mechanisms whereby the individual scientists can communicate their research strategies, problems and results to each other and when necessary they will be able to meet together. The research findings will be brought to bear on curriculum developments. When called upon, Project Literacy will also undertake a program of studies similar to those which will be initiated in other settings.

We believe that much current and potential research in learning psychology, visual preception, cognitive behavior, neurophysiology of vision, child development, descriptive linguistics, psycholinguistics, the sociology of educational innovation, research with culturally disadvantaged children and programmed instruction (to cite some examples) are essential to understanding literacy. Consequently, we are endeavoring to locate research interests which heretofore may not have been considered relevant to this crucial educational research area.